

An Account of my Studies in the Biology of *Pieris rapae*, Linné. II.

By ORAZIO QUERCI.

In a communication, which I made to the meeting of October 27th, 1932, of the American Entomological Society of Philadelphia, I related the result of my research about the life-history of *Pieris rapae*, based on large collecting and breeding and some temperature experiments. My paper is printed in the "*Entomologist's Record*," XLIV. p. 168 (1932). Here I am recording a more complete conclusion and adding new facts.

In the year 1932, at Philadelphia, Pa. *P. rapae* began to emerge on May 15th, and continued to emerge until the 20th of the same month. After a pause of 13 days it emerged again on June 2nd and was on the wing until October 15th.

From May 15th to September 15th the weather varied very little and I found that that nearly every batch of eggs, which I reared, although laid by a single female, hatched at the same time after 4 or 5 days, but while some larvae grew rapidly and became full grown in 7 days, others required 8 to 14 days, and the imagines emerged from the chrysalides in from one to two weeks. *In all my breedings the whole life-cycle never was shorter than 18 days nor longer than 28 days.*

Therefore, I think I am right in stating that, both in spring and summer of 1932, *a new brood began to emerge in the field in less than 20 days after its preceding brood, and that at least eight broods of P. rapae have occurred at Philadelphia.*

As the emergences continue for about 10 days beyond the minimum (18 days after egg-laying) we must have an increase in the duration of the flying period of each successive brood. Besides this, there is another cause of increase due to the fact that some females are on the wing, laying eggs, for about 6 days after their emergence. In total, therefore, *the flying period of each brood should be at least 15 days longer than that of its preceding brood.*

In the following table I am attempting to show how probably the eight broods of *P. rapae* occurred at Philadelphia.

Brood	Emergence began	Emergence ended	End of flight	Days on wing
First	May 15	May 20	May 26	12
Second	Jun. 2	Jun. 22	Jun. 28	27
Third	Jun. 19	Jul. 24	Jul. 29	43
Fourth	Jul. 7	Aug. 28	Sep. 3	59
Fifth	Jul. 25	Oct. 1	Oct. 10	78
Sixth	Aug. 12	(*)	(*)	(*)
Seventh	Aug. 29	(*)	(*)	(*)
Eighth	Sep. 18	(*)	(*)	(*)

(*) Not all the chrysalides of the last three broods will emerge this year. A few chrysalides of the sixth, some of the seventh and many of the eighth brood will go over winter, together with those which might produce a ninth brood, if the season favourable to the emergence of the Lepidoptera is not too short as it happened this year. The chrysalides which will survive will emerge altogether in the spring of 1933.

The data which I record in my table for the beginning of each brood are probably correct, because, as I already said, from most lots of eggs which I have reared until September 15th (when the temperature dropped) some imagines emerged after 18-19 days. That occurred with the greatest regularity. In fact, it is hard to say when the last specimens of every brood emerged.

In an attempt to solve this question I have carefully examined the *P. rapae* in my collection to see if I might find any character, peculiar to the specimens of the same brood, and different from those of the other broods.

All the specimens were taken at the same place in a field near the Fairmount Park of Philadelphia. My wife and I visited that locality every day, also when it was cloudy or raining, as we needed to get plants to feed our larvae. We went there in the morning and returned again to collect in the afternoon when, owing to the heat, the butterflies rest among the tall grass and in the shade of the trees, and it was easy to catch them. Often, two young German friends of mine helped us to collect.

I set the Lepidoptera within rectangular envelopes, made with transparent paper, taking care not to injure those insects which must remain alive. At home I separated both the species and forms.

For the *P. rapae* I selected first all the abnormal ones and later I mounted them. The other specimens were measured, without taking them from the envelopes, and placed in two lots: one of examples having the length of the forewing shorter than 24mm. from the base to the tip, the other of the larger ones. Each of these two lots was subdivided according to the tint: either black or grey, of the tip of the wings. This character is better perceptible when we look for transparency at folded butterflies. When the separation was made I recorded the number of males and females of every form, and later I selected, from the four lots of the most common forms, a few examples to be mounted, and put the others into the cages to fly.

At Lisbon I made a more careful separation of the 747 males and 917 females which I had mounted. I preferred to measure the length from tip to tip of the forewings, instead of measuring one wing alone, because my butterflies are uniformly set with the low margin of the forewings along a line perpendicular to the axis of the body, and measuring is quicker and more exact. To the length of 24mm. for one wing, which I took as a base when measuring folded *P. rapae*, it generally corresponds (except in those of the first brood): 40mm. of expanse when the wings are spread.

In the following table I record the number of males and females of every form of *Pieris rapae* taken at Philadelphia in the year 1932.

To know whether for every brood there is either a peculiar or a dominant form, or not, I have regrouped the preceding data as it is shown in the following table :

Broods	Month	Days	Length from tip to tip of the forewings in mounted butterflies.												Total
			Smaller than 40mm.		Tips of the wings				Larger than 40mm.		40-44mm.		44-49mm.		
			dark	pale	dark	pale	dark	pale	dark	pale	dark	pale			
1st ..	May	15-20	—	—	11 (22)	6 (10)	11 (22)	11 (22)	11 (22)	7 (12)	7 (12)	53 (100)	7 (12)	7 (12)	53 (100)
2nd ..	June	3-20	—	—	53 (20)	15 (6)	90 (32)	67 (24)	29 (10)	23 (8)	277 (100)	23 (8)	23 (8)	277 (100)	
2nd and 3rd ..	June	21-30	—	—	13 (18)	12 (17)	16 (22)	15 (21)	8 (10)	10 (12)	74 (100)	10 (12)	10 (12)	74 (100)	
3rd ..	July	1-5	—	—	6 (15)	4 (10)	16 (40)	8 (20)	1 (3)	5 (12)	40 (100)	5 (12)	5 (12)	40 (100)	
3rd and 4th ..	July	6-25	12 (1)	13 (1)	361 (24)	172 (12)	543 (37)	337 (23)	13 (1)	16 (1)	1467 (100)	13 (1)	16 (1)	1467 (100)	
3rd, 4th and 5th ..	July	26-31	8 (4)	4 (2)	40 (22)	30 (17)	51 (28)	43 (24)	2 (1)	3 (2)	181 (100)	2 (1)	3 (2)	181 (100)	
4th and 5th ..	Aug.	1-10	4 (2)	3 (2)	44 (25)	37 (22)	44 (25)	38 (22)	2 (1)	2 (1)	174 (100)	2 (1)	2 (1)	174 (100)	
4th, 5th and 6th ..	Aug.	11-31	29 (1)	20 (1)	644 (21)	241 (7)	1151 (39)	865 (29)	8 (1)	7 (1)	2965 (100)	8 (1)	7 (1)	2965 (100)	
5th, 6th and 7th ..	Sep.	1-15	6 (1)	2 (1)	128 (16)	75 (9)	311 (40)	244 (31)	4 (1)	5 (1)	775 (100)	4 (1)	5 (1)	775 (100)	
5th, 6th, 7th and 8th ..	Sep.	16-30	32 (2)	17 (2)	152 (13)	128 (11)	457 (39)	356 (31)	7 (1)	7 (1)	1151 (100)	7 (1)	7 (1)	1151 (100)	
6th, 7th and 8th ..	Oct.	1-15	3 (5)	3 (5)	18 (29)	2 (3)	25 (39)	8 (12)	1 (2)	3 (5)	63 (100)	1 (2)	3 (5)	63 (100)	
			94 (1)	62 (1)	1454 (20)	738 (10)	2715 (38)	1992 (28)	82 (1)	83 (1)	7220 (100)	82 (1)	83 (1)	7220 (100)	

In the preceding table the sequence of the broods is set almost in accordance with the data of the table at page 1. The numbers of specimens of every form are also reduced per cent. to make possible their comparison.

The whole surface of the wings of the *P. rapae* of the first brood, which emerged from May 15th to 20th of 1932, is smaller than in the specimens, which emerged later having the same expanse of wings from tip to tip. In my set there are small examples : 36-40mm. (32%) ; middle size ones : 40-44mm. (44%) ; and large ones : 44-48mm. (24%). There are no specimens smaller than 36mm. The pattern of the wings is in

most cases reduced, but the apical scales, which remain, are either black (56%), or grey (44%).

The *P. rapae* on the wing from June 3rd to 20th surely belonged to the second brood. In my series there are no dwarf specimens; 26% are small, 56% of middle size and 18% are large. The apical patch is either black (62%), or grey (38%).

Before making these statistics I was convinced that the *P. rapae* of the second brood should be large and pale at the tips of the wings, but now I am seeing that this form occurs only in the 8% of the specimens taken by the end of spring. Remembering our European captures I must agree that this happened almost everywhere we collected. I think that the mistaken judgment about the *P. rapae* of the second brood is due to the fact that the largest specimens are striking and they raise a desire to get them, while the smaller ones do not attract. The beautiful June *P. rapae* accumulated, year by year in the collections produce in the observer a conviction which does not agree with what really happens in nature.

From my breeding data I inferred that the third brood began to emerge at Philadelphia on June 19th or 20th, and that its specimens overlapped with those of the second brood, which continued to emerge for a few days after that time. From June 21st to 30th the *P. rapae* were scarce, but among the 74 specimens, which we took, most must be of the third brood. I found in my series 35% small, 42% middle size, and 22% large *P. rapae*. The number of these last is larger than when the second brood emerged alone.

By the end of June the second brood had almost certainly ended emergence and the fourth had not yet begun. From July 1st to 5th the *P. rapae* were very scarce, but all the fresh ones should belong to the third brood. In my set there were 25% small (36-40mm.), 60% middle size (40-44mm.), and 15% larger than 44mm.

From June 21st to July 5th most *P. rapae* were of the third brood; 54% of them having a black tip, and 46% a grey one. I must agree that it is not correct to say that the specimens of the third brood are of middle size and with the tip of the forewings deep black.

As also in summer some imagines, from my breedings, continued to emerge 19 days after egg-laying I expected that some *P. rapae* of the fourth brood would have been on the wing on July 7th. On that day I found the first dwarf specimen of the year, and thought that the examples of the fourth brood should be very small. Also in this case the result of the study of the collection does not confirm my idea, as among 1476 *P. rapae* taken from July 6th to 25th, that is when probably the specimens of the third and fourth broods emerged altogether, there are only 25 *P. rapae* (less than 2%) having an expanse of wings smaller than 36mm.

From July 26th to September 30th we found almost every day all the different forms of *P. rapae*. The middle size ones were always prevailing (47 to 70%), those of small size being also frequent (25 to 47%). The average of dwarf *P. rapae* varied from 2 to 6%, that of the larger ones remained always less than 2%.

The statistics based on the 63 *P. rapae* taken in the first fortnight of October have little value as, owing to the troubled meteorological conditions, we were able to catch only a few specimens, and not many as in summer.

My conclusion is that this year, at Philadelphia, no form prevailed in any brood except in the first. I cannot say whether this occurs also in Southern Europe, where the quantity of *P. rapae* is always so scarce during the summer that it is useless for statistics. At Cuença, in Central Spain, with a very favourable season and catching all the *P. rapae*, which we saw, from July 6th to September 5th, we took 57 specimens. This figure is very small if compared with the 5440 *P. rapae* collected at Philadelphia in the same period of two months in the year 1932. I believe that this year *P. rapae* has been exceptionally plentiful in Pennsylvania, because in July and August of 1931 when we visited our collecting place at Parkway every day, we saw not even 30 *P. rapae* on the wing.

In my collection there are 156 *P. rapae*, which I refer to the dwarf form: smaller than 36mm. from tip to tip. If I had set in this lot only those smaller than 35mm. their quantity would have been about half. The lot of *P. rapae* larger than 44mm., are 165 in my set, but only 80 of them have more than 45mm. of expanse. Therefore the really striking examples we took this year, were no more than 150, that is 2% of the 7220 *rapae* which I examined to make the statistics.

LEPIDOPTERA AT MAURIN, BASSES-ALPES, FRANCE,

From mid June to September 8th, 1932.

Based on the Observations of A. E. BURRAS, F.R.E.S., W. PARKINSON CURTIS, F.R.E.S., and W. FASSNIDGE, M.A., F.R.E.S.

(Continued from page 37.)

HETEROCERA.

Ilema complana, L. *I. lurideola*, Zinck. *Endrosa aurita*, Esp. var. *ramosa*, Fb., a few. *Nudaria mundana*, L., one specimen, W.F. *Euprepia cribraria*, L. var. *candida*, H.-S., common at light; W.P.C. has a specimen suffused pinkish, with the entire submedian as far as vein 2 heavily scaled with black, the subcostal scaled black, and the nervures of the hindwings picked out in brown. *Parasemia plantaginis*, L., rare; var. *hospita*, S. and D., by W.F. *Arctia caja*, L.

NOCTUAE.

Chloridea dipsacea, L. *C. peltigera*, Schiff. *Actinotia radiosa*, Esp. *Auchmis comma*, Schiff., fairly rare. *Euxoa fatidica*, Hb., one ♂, A.E.B. *E. segetum*, Schiff., a slaty grey, rather dark form, not apparently noticed by Tutt, *British Noctuae*, Vol. 2. *E. corticea*, Schiff., mainly neutral grey (Ridgway) in tone with the barest tinge of raw sienna. The black scaling is very sooty and the insect lacks the warmth of British specimens. Given the above general tone the forms obtained are referable to *virgata-pallida*, *irrorata-pallida*, *obsoleta-fusca* (the most usual form) *brunnea* and *obscura*: no nomenclotypical form was taken. *E. cinerea*, Schiff. var. *alpigena*, Turati, ♂ ♂ fairly common, A.E.B. *E. puta*, Hb. var. *venitens*, Hb. *E. biriva*, Schiff., fairly rare. *E. griseceus*, Fb., fairly common. *E. decora*, Schiff., common and variable; W.P.C. took ab. *flavomaculata*, Schaw., ab. *livida*, Stgr., and two forms that seem to have escaped a